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THE INVESTMENT RATE OF RETURN AT THE END OF THE PERIOD: A FUTURE WORTH APPROACH TO CAPITAL BUDGETING

Abstract

The Net Present Value (NPV) within the Discounted Cash-Flow (DCF) framework is the preferred theoretical method at the academic level for dealing with capital budgeting problems. However, despite an elegant form and an undeniable technical allure in its Capital Asset Pricing Model (CAPM) version, a large number of situations raise serious concerns about the assumptions that must be made in order to successfully address practical cases. With the aim of obtaining a solution to this issue, the paper develops and proposes a new methodology based on a Future Worth (FW) approach labelled as Investment Rate of Return at the End of the Period (IRREP).

With a couple of real-world cases, we present its effectiveness to contexts where traditional approaches are lacking due to serious theoretical inconsistencies

Keywords: Revenue Management, Capital Budgeting, Decision-Making, Investment analysis, IRREP.

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1. Introduction

Proper evaluation of investments is a fundamental prerequisite for the pursuit of business objectives and in the broader context of efficient revenue management. From this perspective, the scarcity of available financial resources is the critical factor that entrepreneurs must address when selecting various possible alternatives. Similar constraints apply also to organizations outside the "pure business environment"; i.e. for example, public bodies (Mukherjee et al., 2021), non profit organizations (Papke-Shields and Boyer-Wright, 2017) and households (or all those individuals who do not act as entrepreneurs). The nature of the problem is essentially the same: the need for a practical and efficient criterion to be adopted.

In their essence, the long-term economic problems are generally approached through an investment cost-benefit analysis (Kaplan, 1986). The most employed and credited capital budgeting technique is of strictly financial origin and is based on the Discounted Cash-Flow (DCF) method (Focacci, 2017). In this context, the implementation of the Capital Asset Pricing Model (CAPM) has been the benchmark for over forty years (Shih et al., 2014). Its appeal does not seem to fade (Dybvig and Ross (2003).

With the aim to enhance practical implementation of capital budgeting techniques, this paper proposes a Future Worth (FW) modified based approach to perform investment analysis. The resulting indicator is named: Investment Rate of Return at the End of the Period (IRREP). The objective is twofold: (1) to introduce new quantitative metrics able to support these kind of decisions, and (2) to show their flexibility and adaptability to various application contexts overcoming all unrealistic and "esoteric" assumptions generally adopted in practical implementation of the traditional approach.

Through a couple of real cases, we show its implementation. The method proves its versatility without neglecting the relevant bindings of economic/financial theoretical principles.

The paper is organized as follows. The next section carefully reviews theoretical aspects of DCF and its inherent shortcomings to point out the need of a different methodological approach. Section 3 introduces the modified future worth algorithm and shows calculations for two real examples in sub-sections 3.1 and 3.2. Finally, Section 4 concludes.

2. The DCF analysis for investment assessment and its shortcomings

To address investment assessment, a great wealth of theoretical and empirical literature has been focused on valuation methods based on DCF analysis. The acknowledged merits underlying the DCF lie in Time Value of Money Law (TVOM) (von Böhm-Bawerk, 1921 and Fisher, 1930). To develop the calculations the essential starting point is always represented by the cash-flow forecasts (CF). The methods of accounting for CFs are summarized in the Appendix where all symbols and acronyms are detailed in their meaning. TVOM weights CFs accruing today more than those accruing in the future through the application of a discount rate. The Net Present Value (NPV) is the result of this calculation (also the NPV mathematic fundamentals are included in the Appendix). The early reference to NPV can be found in "The Rate of Interest" (Fisher, 1907), and the first textbook discussing the application of these techniques for capital budgeting was proposed by Grant (1930).

Despite its formal accuracy, the practical implementation of the DCF coupled with CAPM encounters several pitfalls. Overcoming these inherent constraints severely limits and challenges its effectiveness in two main respects.

First of all and according with theory, it is possible to approximate the cost of equity (r_E) deriving the r_f by considering the yield of Government Bonds having similar maturities with the duration of project. Nevertheless, as of 2013 fiscal year, and taking as an example Italian State Bonds, new issuances must be subject to the European Union (EU) rules imposing the Collective Action Clause (CAC) as required by the Treaty on the European Stability Mechanism (ESM). By this new regulatory framework, EU sovereign debts may be restructured under certain conditions and the genuine risk-free rate inferred from Government Bonds becomes a very questionable and weak concept. Therefore, the r_f looks like more as a mere intellectual speculation than a practical parameter to introduce in calculations. This problem is emphasized today by the Country risk, as international sanctions and bans show.

Secondly, the β determination is not a straightforward process, and two alternative methods tackle the need. The easier and more pragmatic solution resorts to specific publications (for example Beta Books or financial reports) as well as some financial websites. A more elaborate procedure applies a regression function between historical time series of market and stock returns data. Since exploiting the ergodic properties of economic systems reflected in the time series (and for this reason labeled as "raw or historical β"), it requires further refinements. An appropriated discussion both of the specific regression technique and of the adjustments based on the Gini measures can be found in Shalit and Yitzhaki (2002). As can be easily pointed out, less structured organizations and/or Small Medium Enterprises (SMEs) can hardly implement and rely on such refined statistical methodologies. Moreover, the β derivation is not possible for all those companies (usually the majority) that are not publicly traded.

Additional critical aspects lie in the business risk changes and/or in the firm debt ratios. An implicit assumption underlying the Weighted Average Cost of Capital (WACC, see Appendix) is that leverage ratio (the fraction of debt to equity) is maintained constant when the new project is undertaken. In the event that this is not possible, the recommendation is to consider the differences between the risk of the new project and the systematic risk of the company. Also in this case, there are two potential alternatives. The first involves the entire WACC, and the second the β.

With regard to the WACC there is a refining procedure in three phases (Brealey et al.,2017). Firstly, the WACC is *unlevered* simply leaving out the taxes effect in its formula (coherently with Modigliani and Miller's argument that debt policy of the firm is not relevant):

$$WACC_{UNL} = r = r_E \times \frac{E}{V} + r_D \times \frac{D}{V} \quad (1)$$

Secondly, the new cost of debt r'_D at the new debt ratio $\frac{D'}{E}$ is estimated to obtain the new cost of equity r'_E (2):

$$r'_E = r + (r - r'_D) \times \frac{D'}{E} \quad (2).$$

Finally, the cost of capital is *relevered* (here labeled as WACC') consistently with the fact that a higher leverage ratio leads to a slow down in the rate of increase in the expected return of equity (or cost of equity) following the increased risk of higher overall debt (Modigliani and Miller, 1958):

$$WACC' = r'_E \times \frac{E'}{V} + r'_D (1\text{-}t) \times \frac{D'}{V} \quad (3).$$

As aforementioned, the calculation may be alternatively implemented also at the β level. In such a case, as a first step, Titman and Martin (2011) suggest to identify a group of firms operating in the same business of the subject firm and gather their levered equity βs from common financial archives. The underlying theoretical starting formula to be processed is:

$$\beta = \beta_E \times \frac{E}{V} + \beta_D \times \frac{D}{V} \quad (4a)$$

wherein β is the Beta of total assets (or β_{UL} Beta *Unlevered*), and β_E is the Beta equity (or β_L Beta *levered*). Considering the equivalences, the (4a) can be also expressed as:

$$\beta_{UL} = \beta_L \times \frac{E}{V} + \beta_D \times \frac{D}{V} \ . \quad (4b)$$

Without detailing each algebra step for brevity, when the firm's capital structure is updated continuously (the most common real situation), the unlevered β_{UL} is achieved for each unity of the sample through the following:

$$\beta_{UL} = \frac{\beta_L + \beta_D \times \frac{D}{E}}{1 + \frac{D}{E}} \quad (5)$$

where:

- β_L = denotes the Beta equity value (or levered) retrievable from usual financial sources as previously stated (β_s);
- β_D = is assumed in a reasonable estimation equal to 0.30 considering the normal risk of default;
- $\frac{D}{E}$ is the leverage ratio .

Subsequently, once a corresponding sample average value β'_{UL} is derived, a β_L for the subject firm with the new leverage ratio $\frac{D'}{E}$ will be determined as follows:

$$\beta_L = \beta'_{UL} \times (1 + \frac{D'}{E}) - \beta_D \times \frac{D'}{E} \quad (6).$$

Finally, this β_L is inserted into the WACC formula jointly with the new leverage ratio and the new cost of debt.

Additional anomalies and critics versus (also the theoretical foundations of) the CAPM are highlighted by Fama and French (1992, 1993, 1996 and 1997), Grinold (1993) and Wallace (1980). Empirical exercises supporting CAPM positions are proposed by Dawson (2014), Da et al. (2012) and Jagannathan and Meier (2002).

A summary list of all assumptions needed to support the whole refining procedure in CAPM methodology is reported in Table 1.

Table 1 – List of unavoidable assumptions in WACC estimation by CAPM adoption

Term of the formula	Assumption to be made
E and *D*	Market values
r_f	Yield of Government Bonds
	(As of 2013 CAC)
$(r_m - r_f)$	Historically to be derived/regressed from market data
WACC	unlevering and relevering following targeted leverage ratios
β	from historical to perspective value
	unlevering and relevering following targeted leverage ratios
	average calculation within a sample of reference

Source: Personal elaboration

As a special DCF case to mention, the Internal Rate of Return (IRR) is defined as the rate of discount making NPV = 0:

$$NPV = -I_0 + \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t} = 0 \qquad (7)$$

wherein the only unknown is i , i.e. IRR. The classical contributions on the IRR methodology can be found in Alchian (1955), Lorie and Savage (1955) and Solomon (1956). In this case, a specific attention is devoted to the signs changes within the stream of cash-flows. If more than one cash-flow sign changes, Descartes' rule shows that more than one positive real root/solution (or also no positive roots) exists. Classical decision rule states that the project should be accepted, if the calculated IRR is higher than investment opportunity cost of capital. Under a strictly economic perspective, the IRR may represent the cost of a loan having the same stream of cash-flows of the project. Without requiring to estimate and introduce in calculations an appropriate interest discount rate, it should reduce subjective assumptions to the CFs estimation providing a measure of the return of the investment under the implicit assumption of reinvesting cash-flows at the same rate for the whole period. Unfortunately, the re-investing assumption is very constraining and questionable in practical terms. As well-known, in the typical long-run horizon, there is not a flat constant curve in the term structure of interest rates (yield curve). Hence, despite its widespread adoption, it may be a misleading indicator of profitability (Cuthbert and Magni, 2016). For these reasons, the IRR lacks a real and comprehensible economic meaning.

At this point, it can be pointed out that the final aim of all DCF assumptions is to deal with investment uncertainty.

As far as the risk (and uncertainty) is concerned, further theoretical and sophisticated academic efforts have been directed toward more refined valuation methods (real options), trying to exploit some common features with financial options (Kim and Sunders, 2002). However, from a practical standpoint, these methods suffer from additional shortcomings for effective implementation due to inherent differences relative to their natural environments:

-financial products have regulated and standardized markets where trades are continuous and frequent;

-in real projects, deals occur with low frequency rate and no standardized transaction procedures exist;

-within financial options markets, strictly mathematical processes are focused on a binary decision basis and they are formalized through the pricing evaluation model developed by Black and Scholes (1973).

Along with option models, other approaches to manage uncertainty in practical situations are the qualitative processes such as scenario planning (Alessandri et al. 2004) or the decision trees methodology. This latter is a formalized diagramming technique for evaluating the scenario with multiple outcomes (Magee, 1964; Hespos and Strassmann, 1965).

To complete this overview of the significant shortcomings that prevent reliable evaluation and management of the investment decisions through DCF methods, three other issues need to be pointed out.

The first takes into consideration the firm size as previously highlighted. According to an authoritative statistics source, in the USA SMEs represent 98.4% of the market, and in the EU28 this percentage is even higher at 99.2% (OECD, 2015) Mostly, these entities are not publicly traded and historical Betas are not available. To deal with these situations, theory and best practices advise to consider the determinants of Asset Betas like: cyclicality, operating leverage and (not well specified) "further factors" (Brealey et al., 2017). According to this view, higher cyclical firms have naturally higher Betas (since their higher linkage with the overall performance of the economy).

Higher operating leverage is a defining trait of more "fixed-cost oriented" structures that bear relatively higher risks (Mandelker and Ghon Rhee, 1984 and Lev, 1974). The "further factors" must be included in an overall estimate through the search for specific clues able to furnish useful indications. On this issue, for example Damodaran (2015) points out the higher risks of smaller firms compared with larger corporations (small firm premium). Sato et al. (2017) add that we often have to rely on past experience, generalities and intuition.

Despite all prescriptions, the unsolved question remains both the measure and the correct methodology to estimate such additional premiums. Thus, doubts about the validity of all these approaches are not dispelled.

Secondly, another set of constraints involves the Government and (more in general) public sector projects. These are not negligible corollaries since the most relevant investments are generally undertaken by state owned companies. In comparing private and public projects, it must be observed the intrinsic differences in distinctive linked to the nature of respective activities. In this issues, more as an exception than a rule, we note that in the case of USA, the Office of Management & Budget (OMB) supports public entities' decisions through specific guidelines (i.e. circular no. A-94 and subsequent up-dates) (White et al., 2012). Broadly speaking, in the public sector a reasonable estimate of the cost of equity cannot follow CAPM insights because no comparable subjects exist. In this case, the CAPM is reduced to a criterion with a fairly limited scope.

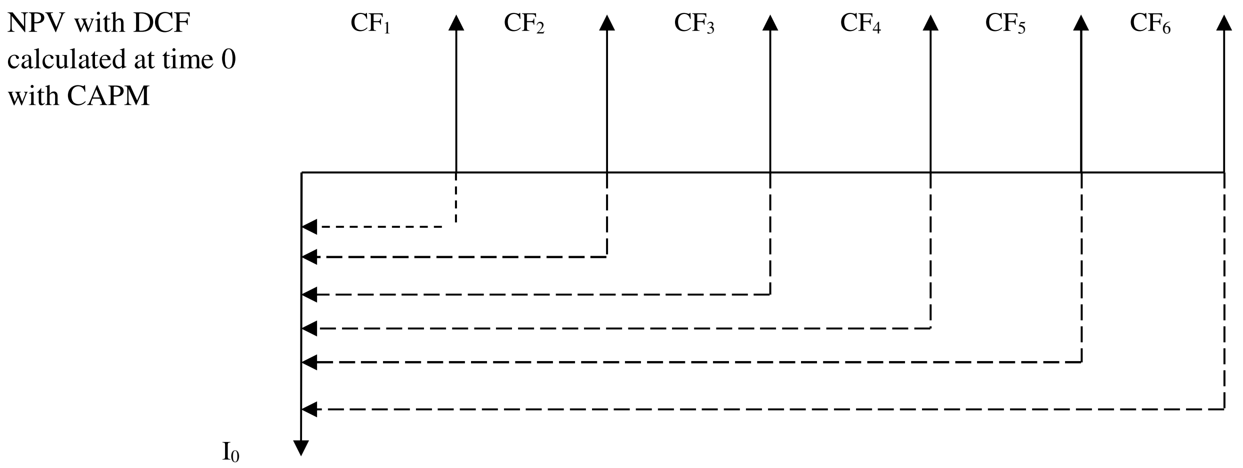
The last but not least case to be analyzed is that of individuals and households (outside of business contexts). Their decisions have the same techno-economic features of projects undertaken by companies in the market. Thus, these cases should also be included in an effective overall investment decision analysis system. Relevant examples can be drawn from the diffusion of the renewable energies in the last ten years. In several Countries all over the world, a growing number of households/individuals experienced the pros and the cons of installing technological devices:

photovoltaic (PV) rooftop plants, heat-pumps or home wind energy facilities. Given the absence of comparables entities, difficulties and concerns similar to those already illustrated for the public sector can be seen in the practical implementation of the CAPM. The problems of a fair valuation of corporate assets is also recently emphasized by Bradley et al. (2021).

3. The Future Worth and the Investment Rate of Return at the End of the Period

As discussed in the previous Section, underlying assumptions (and analyst's experience) play a pivotal role in the CAPM based valuation process. In addition, it can reasonably argued that any final outcome is too dependent on adjusted and unrealistic considerations included in the various steps of the procedure. Albeit elegant and justified under some theoretical point of views, the determination of the discount rate may also appear as a shallow exercise. At this point, all adjustments applied in CAPM models appear as a sequence of approximations.

With the aim to propose an evaluation approach consistent with the need to provide greater accountability (including public accountability), the analysis should simply be centered on the essential (and unavoidable) variables of the entire process: expected cash-flows (Wang and Eichenseher, 1998). However, in order to overcoming all the relevant pitfalls descending from the NPV implementation, cash-flows should be treated following a totally different perspective. For this purpose, the Future Worth (FW) -or equivalently Future Value- by means of a modified compound interest calculation method shows very interesting features. Firstly and foremost, it allows to relax all unrealistic assumptions underlying the NPV approach (Fig. 1, the period equal to 6 years is a merely example).



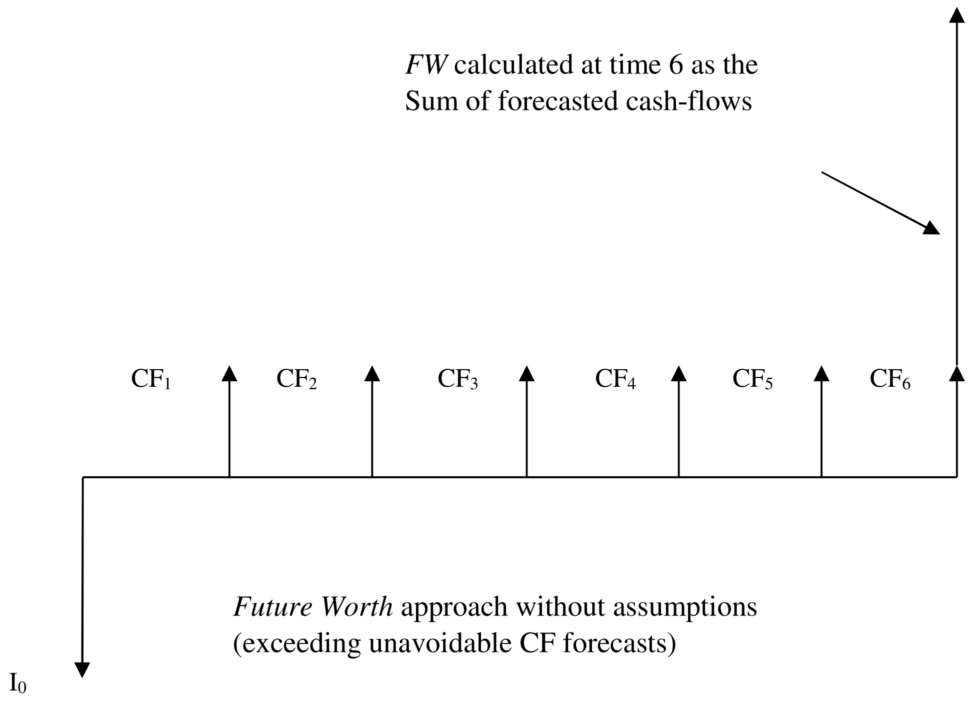


Fig. 1- Example of Cash-flow diagrams both in the NPV framework and in the proposed modified Future Worth (FW) approach for a 6 years investment

Moreover, and as a most meaningful aspect similar to IRR, such a modified FW approach leaves just one unknown in the calculation that can be mathematically derived from the subsequent algorithm:

$$I_0 \times (1 + r)^n = \sum_{t=1}^{n} CF_t \qquad (8)$$

wherein each symbol has the familiar meaning, and the only term to determine with a (very) simple algebra is the r . By this solution, the interest rate r -labeled in this work as Investment Rate of Return at the End of the Period, IRREP- is endogenously and directly derived from the expected cash-flows without coercing additional (or weird) theoretical assumptions. Its calculation can be derived from:

$$r = \text{IRREP} = \left(\frac{\sum_{t=1}^{n} CF_t}{I_0}\right)^{\frac{1}{n}} - 1 \qquad (9)$$

As a brief methodological note, it must be pointed out that the present IRREP is different from the Modified Internal Rate of Return (MIRR) proposed by Lin (1976) (10):

$$\text{MIRR} = \left(\frac{\sum_{t=1}^{n} CF_t\,(1+i)^{n-t}}{I_0}\right)^{\frac{1}{n}} \qquad (10)\ .$$

As can be seen, even if methods share a common FW origin, the cash-flows at the numerator of the IRREP are not singularly converted to future values relaxing (also in this case) the unrealistic assumption of the reinvestment of each subsequent available sum. The yield-curve path is sufficient to consider unreasonable the constant reinvestment rate expectation. Furthermore and differently from MIRR, where hypothesis about the cost of capital are essential to proceed in calculations, no market rates (and related assumptions) are required in IRREP determination.

At this point, the information content retrievable by the IRREP will be to undertake investments having an IRREP > 0 whether such a result is (subjectively) considered in line with organization's project policy and its preferred thresholds. Opposite considerations will pertain projects having an IRREP < 0 (the investment will not add economic value to the firm/organization). As a result of the diversity in the specific mission if compared with profit organizations, public/non-profit entities and individuals/households may have a threshold for the IRREP ≥ 0. In this case, only investments having an IRREP > 0 are expected to repay costs. Obviously the indifference condition will be for an IRREP = 0, and additional (for example social or environmental) considerations may advise to undertake the project even if its expected worth is (about) zero. Naturally, projects having an IRREP < 0 should be carefully assessed, and (hopefully) rejected. Some concerns may arise when considering the CFs originated from bank loans possibly obtained by the company, the organization or the individual. This is not a real issue, in fact it is sufficient to add all the cash inflows and outflows generated by the loan within calculation to obtain a net IRREP. In this way, we will include the financing costs too. Related to this concern is also the subsequent one. In fact, if the CFs estimation were represented by a sequence of positive and (also alternate) negative values (due to outflows to repay the loan), this would not be a constraint, because the calculation can be performed by obtaining the IRREP derived from this configuration of expected CFs.

A potential shortcoming of this indicator could be identified when the investor has to rank competing projects having the same IRREP but different streams of CFs. In order to address this reasonable concern, a specific refinement of the procedure can be proposed through an example. Taking two investments A and B having the respective cash-flows stream hereunder reported:

$$A = (-100, 20, 20, 40, 40, 50), \quad B = (-100, 70, 70, 10, 10, 10),$$

the related IRREP calculation leads to the same solution for both projects (11.20%). However, by analyzing the pay-back period, B should be preferred to A because higher cash-inflows occur earlier (payback B about 2 years versus payback A about 5 years). This intriguing question can be easily overcome by adopting an appropriate weighting model of CFs leading to a more general formulation of the IRREP. Such a solution implies that the each CF is compared with the initial investment I_0 in each period. Starting from the algorithm already developed in (8), and considering for each period $t = 1,2,.....n$ a weighting ratio w_n equal to:

$$w_1 = \frac{CF_1}{I_0}\ , w_2 = \frac{CF_2}{I_0}\ , \ \ldots\ldots\ldots\ldots \quad w_n = \frac{CF_n}{I_0}$$

In this way we take into consideration the specific temporal moment in which the CFs occur. It is possible to add this weighting factor w_t to the (8) as :

$$I_0 \times (1 + r)^n = \sum_{t=1}^{n} CF_t\ w_t \quad (11).$$

Also in this case, the only unknown is the rate r.

By adopting this approach, the solution that is derived does not represent the financial yield (still constituted by the IRREP obtained with its ordinary formulation), but an evaluation criterion to rationally define a ranking method for the selection of projects. Applying the (11) in the above cited example, for investment A the result will be equal to -8.25%, while 0.20% will be the result for B.

This result is consistent with the pay-back considerations made previously, and one single (and incontrovertible) solution is achieved to rank projects.

The main managerial implications and enhancements in the effectiveness of a capital budgeting process based on the proposed algorithm can be listed and discussed below.

First of all, the method does not violate the TVOM within a financial assessment framework (according to the current merits of the NPV). In fact, by applying the compound interest calculation, the TVOM holds taking into account the simplifying (and precautionary) assumption of a FW equal to the simple sum of the various cash-flows at the end of the period.

Secondly, FW calculations embed inflation through expected cash-flows forecasts. Distinctly from IRR model possible sign changes in cash-flows do not affect the IRREP calculation.

A third merit lies in the information content. Differently from the incomprehensible current IRR interpretation, this univocal IRREP measure is easy to understand. At a first sight, even if this choice could be perceived as an oversimplification underestimating the rate of return, such a solution is more coherent with the risk aversion concepts permeating both profit and non-profit organizations management principles. For example, also in the banking sector lending policies will benefit of a more prudential indicator employed to assess firms' investment projects. The role of microeconomic variables in addressing financial crises is pointed out in Ghardallou (2021). Compared with the NPV in its CAPM version, by avoiding the plethora of assumptions to include and "refine" through the practical implementation of adjustments, the IRREP will improve the intrinsic speed and efficiency of the decisional process limiting subjectivity that could lead to artifacts.

Additionally, an IRREP approach is much more compatible with economic and management goal setting principles. In fact, being the calculations not affected by the term structure of interest rates, simpler comparisons between actual and expected CFs can immediately convey the right information to the managers (decision-makers) on the project's progress.

Finally, as the examples taken from two completely different contexts in Sections 4.1 and 4.2 will show, the adoption of the IRREP greatly improves the flexibility of investment evaluation. In fact, it increases information power without resorting to "ad hoc (weird) theories" to adapt and justify the calculation to be applied in the different areas. Large quoted companies, SMEs, Government Bodies, Non-Profit Organizations, individuals and households can count on the same algorithm (despite the expectations in the thresholds of expected returns are different) reducing also interpretation drawbacks.

3.1 Case 1: The evaluation of a PV investment undertaken by a SME

Primarily, it must be pointed out that both the present and the subsequent case are collected from international literature where the full stream of cash-flows have been detailed. This allows to appropriately manage the figures for the research aim of the paper.

Case number 1 reports data deriving from an italian SME having the legal status of Società a responsabilità limitata (acronym Srl). Investment consisted of an about 600 KW_p PV plan installed in 2012 fiscal year on the roof of the factory-building. Cash-flow calculations and estimates have been developed in line with existing in-force Italian laws at the date of the elaboration of the feasibility study (2011). The main starting assumptions are:

-total capital expenditure of 1,164,920 € (VAT excluded considering the firm status of the entity undertaking the project);

-depreciation rate 4% per year (during the first year the rate is the half of the entire rate 9% -starting from fiscal year 2012- such a rate has been changed into 4% according to revised Italian tax rules for PV plants);

-inflation rate 2% per year;

-no terminal value or cost to dismantling the plant are included. This is a very important limitation in assessing the real value of these kind of projects (firm owners decided not to include these items into calculations);

-WACC equal to 10.78% as defined in the project business plan by the supplier proposing the investment.

Partners decided to finance the overall first outlay without recurring to bank loans. The whole stream of cash-flows are summarized in subsequent Table 2. A more detailed break- down is available in the original source (not reported here for brevity).

At a first sight, analyzing the proposal, this is a very good investment to undertake. However, it is possible to refine the analysis of the data. Firstly, as previously explained, IRR is not a real return; thus a 12.85% rate is a totally misleading (and useless) information. In fact, at the end of the period the sum of cash inflows for the Partners is expected to be equal to 3,321,354 €. Whether the real return on the initial disbursement were the 12.85% in 20 years, the expected sum in a compounding interest environment would be higher and equal to 13,025,304 €. In all evidence, the information content of the return of 12.85% is meaningless. Secondly, calculated and proposed NPV may hide some pitfalls. Undoubtedly, information asymmetries cannot be excluded in CF forecasts (e.g. the progressive reduction of the solar conversion factor of PV cells). Third, it is difficult to understand how the proposer estimated the firm's internal WACC in order to propose the NPV estimate.

Among the various pitfalls, have the proponents really accessed to the data of the firm to evaluate the leverage ratio? And βs how are determined? There are no comparable. Ultimately, it can be concluded that the rational validity of such a measure is very poor (obviously no information is available on this aspect). In this situation, the advantage of applying the IRREP is clear, because there is no need to use this information once the CFs have been estimated.

Table 2-Investment Cash-flows from the business plan Case 1

	Year	€
Capital expenditure with the initial outlay	2011	-1,164,920
Expected Cash-flows	2012	158,608
	2013	163,394
	2014	163,617
	2015	163,847
	2016	164,084
	2017	164,327
	2018	164,578
	2019	164,836
	2020	165,101
	2021	165,373
	2022	166,495
	2023	167,289
	2024	167,589
	2025	167,897
	2026	168,213
	2027	168,537
	2028	168,871
	2029	169,212
	2030	169,563
	2031	169,923
IRR		***12.85%***
NPV @ 10.78% WACC		***164,824***

Source: Personal elaboration from Focacci (2017)

Loosening the (very unrealistic) assumption of reinvesting obtained CFs at the same rate as specified above, the compound interest return on this investment over the twenty-year period for expected CFs can conservatively be calculated as 5.38% (plummeting from the proposed and opaque 12.85%). The result is consistent with the NPV results. An IRREP > 0 shows that the investment can repay the initial outflow with an additional worth. At this point, totally different is the information content and subjective awareness in considering the investment. In fact, the question is not related to the economic benefit of the project as positive NPV and IRREP would suggest. From a more rational perspective, the issue relates to the (subjective) judgement of investors in undertaking this twenty-years project with a compounded rate of return of about 5% and an upper threshold (only theoretical) of 7.53%. In addition, because of (probably) overestimated and overly optimistic CFs forecasts, an additional managerial concern is to consider the possibility that one may (in fact) be getting a lower rate of return.

3.2 Case 2: The evaluation of a residential PV investment

This investment considers the rooftop PV system installed in 2008 by a family to meet household energy needs. Assumptions include that a nominal power solar plant of 2.70 kW_p is purchased at a cost of 16.730 € (VAT included), and legislative framework is maintained constant. As reported by Focacci (2009), the CFs are estimated according to the Feed-in tariff mechanism introduced by the New Conto Energia for domestic use (Ministerial Decree dated 19 February 2007) through the net-metering scheme for small residential applications. Cash-flow estimates are summarized in Table 3. As in the previous case, no further considerations regarding dismantling future costs are included (however, as in the previous case, their addition to the calculations would not be an issue).

Incidentally (and unexpectedly), it must be pointed out that Italian Government as of 2015 has modified the regulatory framework changing also previous signed agreements. Hence, nowadays, the actual CFs report is surely different from the original one. However, considering that the investment assessment was made in the 2008 fiscal year, the original source can still be usefully employed without changes in the published figures. NPVs calculations were developed by adopting, as a base for the opportunity cost estimate, the yield (at that date) of an Italian treasury Bond (BTP) having the same maturity of the feed-in mechanism (20 years).

Table 3- Investment Cash-flows from the business plan Case 2

	Year	€
Initial outlay less first fraction of the year incentives	2008	-15,049
Expected Cash-flows	2009	1,692
	2010	1,704
	2011	1,707
	2012	1,724
	2013	1,744
	2014	1,768
	2015	1,793
	2016	1,824
	2017	1,857
	2018	595
	2019	1,937
	2020	1,983
	2021	2,034
	2022	2,092
	2023	2,155
	2024	2,226
	2025	2,303
	2026	2,385
	2027	2,478
IRR		***9.97%***
NPV @ 5.8 % opportunity cost		***5,695***
NPV @ 9 % opportunity cost		***1,084***

Source: Personal elaboration from Focacci (2009).
Note: Original work probably presented a typo error in the *NPV* calculations. This does not affect the conclusions of the research. In the present Table *NPV* has been corrected after recalculations. *IRR* is correct also in the original source due to rounding.
The 2008 year includes both the initial cash outflow and the first cash-inflow

As can be seen at the end of the Table 3, two different scenario with two different opportunity costs were proposed for prudential reasons (both resulting in positive NPVs). Also in this case, the IRR is a misleading indicator. In fact, it overestimates a rate of return equal to 10% (rounded); if this were the case the investors should have a total sum at the end of the period equal to 87,384 € (on the contrary, the expected final amount is well-below and equal to about 36,000 €). By applying the IRREP, the project return can be estimated at a lower (and prudential) 4.70%. Interpretations, issues and questions are substantially equivalent to those already proposed and derived at the end of the Section 3.1.

4. Conclusion

Evaluating investments' financial performance is pivotal to align organizations with their strategic direction. New enterprises, start-ups and, generally, firms facing very turbulent economic environment (i.e. high-tech firms) as well as public bodies and households have the similar needs. Starting from a deep review of DCF implementation issues, in the present work a different method to calculate the investment return is proposed. By developing an algorithm based on the FW concept, a new measure for investment analysis (labeled as IRREP) is derived. The method is suitable for quantitatively and qualitative enhance the information content linked to business process management in the investment assessment phase. By adopting an appropriate weighting factor the method can also be applied to rank competing projects when the stream of CFs may appear to be misleading. Moreover, as illustrated by two real cases, this modified FW application can easily overcome all issues generally encountered in NPV implementation. In fact, no special assumptions need to be added to the estimate (necessary and unavoidable) of CFs. This feature enlarges the field of application to all potential long-term decisions. Obviously, the method can be applied to alternative investments also in the case of different initial disbursements by adopting a simple scale factor.

Main limitation of the study can be identified in the fact that the final rate of return of the project could be underestimated because no reinvestment of subsequent CFs is considered. Nevertheless, such critics are more than balanced by the counterargument that the implementation of unrealistic and over complicated procedures cannot be considered as beneficial alternatives. Furthermore, this precautionary assumption is more consistent with the risk-aversion principles of organizations and individuals than –for example- the unrealistic information that can be derived in IRR calculations.

Considering the objective (1) of this research, we show that the concept of modified FW can be usefully adopted for the purpose of elaborating a quantitative measure capable of usefully representing project return. The related implication is that such an approach is applicable in order to improving the investment appraisal process in the organization. Additionally, this is an easily implementable decisional tool considering the very limited requirement of resources for its effective adoption. CFs forecasting is however mandatory for any organization that wants to evaluate an investment.

Coherently with the second goal of the contribution (2) stated in the Introduction Section, we show that FW framework has a specific concreteness since no theoretical models and "ad hoc" assumptions are required for its pragmatic implementation. Thus, a consequential implication is that this approach seems more appropriate and effective in supporting project selection, because the methodology relies solely on the (unvoidable) CFs forecasts without additional exogenous elements influencing the calculations as in the case of DCF in a CAPM framework. The results are consistent with NPV outcomes, and the distinctive advantageous features lie in the enhanced investment information content recoverable from the IRREP. Furthermore, the outcomes are achieved with a much smaller number of starting information and without resorting to approximations or subjective assumptions.

For what concerns the flexibility of the methodology, we can point out the investment return based on IRREP can be applied to projects undertaken by whatsoever kind of organization. There are no limitations regarding economic sector or activity.

Possible future developments of this research are related to the collection of further complete project data (documented in published papers to have the possibility of replication) where the full CFs and the NPV procedure are clearly detailed. This collection will contribute to build an archive useful for refinement applications on expected cash-flows (for example by adopting Montecarlo techniques). A further interesting research strand to implement is linked to the integration of sustainability and environmental concepts within project return measures.

As proposed, this approach is totally coherent with the need of increasing the information content of capital budgeting techniques for all kind of investments. We show that by applying a modified compound financial calculus, it is possible to achieve a reliable improvement in decision making for different types of investors, whatever industry and activity they are involved in.

Appendix. The NPV calculation

In its simpler mathematical formulation the NPV is represented as:

$$NPV = -I_0 + \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t} \quad (1)$$

where:

- $-I_0$ is the capital initial cost to pay (cash-outflow);
- CF_t are the yearly (expected) net-cash inflows;
- n is the number of years included in the evaluation time of the investment;
- i is the opportunity cost of capital or interest rate (discount); it represents the expected rate of return at which investors renounce for alternatives with equivalent risks (Thuesen and Fabrycky, 1989).

The decision rule considers that the investment must be accepted if the calculated NPV is > 0. Among different alternatives, the project having the higher NPV should be the preferred one. The essential distinctive trait of such a methodology is the adoption of CFs. In fact, unlike net income, CFs are not affected by managers' discretionary accounting policies.

The methods of accounting for CF measurement can be proposed in two different forms:

-Unlevered Cash-Flow (UCF or Free-cash flows to operations, FCFO) to represent the cash-flows realized without debt financing (direct method to calculate UCF is detailed within Table 1);

-Equity free cash-flow (or Free cash-flows to Equity, FCFE) to measure amounts available for distribution to equity holders equal to:

FCFE = UCF – after tax interest expenses + new debt proceeds – principal repayments.

Table 1 - Investment *UCF* calculated by the direct method

Sales
Less: Cost of goods sold
Gross Profit
Less: Operating expenses (including depreciation)
Earnings Before Interest and Taxes (EBIT)
Less: Taxes
Net Operating Profit after Taxes (NOPAT)
Plus: Depreciation, amortization and other non monetary costs
Less: Increases in Net Working Capital (NWC)
Plus: Decreases in Net Working Capital (NWC)
Less: Capital Expenses (CAPEX)
Plus: Proceeds from the sale of capital goods
Unlevered Cash-Flows (UCF) or (Free cash flow (FCFO)

Source: Personal elaboration from Titman and Martin (2011)

In the NPV formula the most relevant and critical aspect to mention is the correct identification of the opportunity cost of capital. In fact, underlying assumptions adopted for its definition play always a pivotal in the whole estimation (Borgonovo and Peccati, 2006).

Without resorting to common "finance-spoken" jargon, a lower opportunity cost of capital overestimates the final NPV, while a higher value underestimates the final NPV. In its most common solution (Pinto, 2013), the Weighted Average Cost of Capital (WACC) is the preferred model for approximating the appropriate opportunity cost of capital:

$$WACC = r_E \times E/V + r_D \times (1\text{-}t) \times D/V \quad (3)$$

where:

- r_E = is the required rate of return expected by firm's owners (cost of equity);
- r_D $(1\text{-}t)$ = is the required rate of returns expected by firm's creditors (cost of debt), adjusted by a factor equal to 1 minus the corporate (or marginal) tax rate;
- E/V = is the market value of equity;
- D/V = is the market value of debt.

The main issues with WACC practical application lie in the cost of equity (r_E) determination (Firer, 2015 and Glova, 2015). Literature points out that for its estimation it is commonly adopted the original Capital Asset Pricing Model (CAPM) (Shih et al., 2014). Graham and Harvey (2001) in a survey involving 392 Chief Financial Officers found that about 73.5% of the respondents recommended the CAPM for project analysis. Similar percentages (75%) among academic finance professors' opinions were reported by Welch (2008). The CAPM (Sharpe, 1964; Lintner, 1965 and Mossin, 1966) derives the cost of equity from the following expression:

$$r_E = r_f + \beta (r_m - r_f) \quad (4)$$

where:

- r_f = is the risk-free rate (usually taken from Government Bonds);
- r_m = denotes the rate of return of the market portfolio (often approximated by the rate of return of the stock market index);
- β = represents the systematic risk of the firm's (common) equity and is a measure of the market risk or (better) the specific company sensitivity to market movements.

The Beta is statistically derived as:

$$\beta_i = \frac{\partial_{im}}{\partial_m^2} \quad (5)$$

wherein:

- β_i = is the beta of the share of the company *i*;
- ∂_{im} = is the covariance between the returns of the share of the company *i* and the market returns;
- ∂_m^2 = is the variance of the market returns.

Stock return volatility is varying across time and firms., and it is widely assumed as a measure of risk both in financial theory and in practice.

Additionally, the WACC is adopted also in the Economic Value Added Model (EVA®) originally introduced by the consulting firm Stern Stewart & Co. (Stern et al., 2001). The equivalence between NPV and EVA® models is treated, for example, by Hartman (2007) and Shrieves and Wachowicz jr (2007). Nevertheless, contrary to some common claims, EVA® and NPV do not produce the same accept/reject decisions in a variety of classical capital budgeting situations (McClatchey and Clinebell, 2004).

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